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(54) Arrangement for initiating of inflator in several steps

(57) The invention describes an arrangement for initiating of pyrotechnical inflators especially for passive restraint systems, in several steps. Up-to-now pyrotechnical inflators are initiated in one level (step), i.e. there is only one initiator, which initiates the complete fuel comprised in the inflator. According to the invention a pyrotechnical inflator comprises a plurality of initiators and fuel units being independent from each other, which individually may be initiated. By this the inflator can be initiated in one or several steps. The adjustment of the wished gas amount, of the wished gas pressure and of the inflating speed can take place by this according to the requirements immediately at the point of time of the initiation. By this invention every person can be optionally protected in every position in the passenger compartment under any condition. The danger of injury because of too high or too low pressures is excluded.

Fig. 1

Specification

The invention concerns an arrangement for initiating inflators according to the prior-art-part of claims 1, 6 or 7 in several steps.

For passenger restraint systems provided with an airbag are known, which is inflated by gas generated by an inflator. For this mainly two types of inflators are known which utilise a burnable solid gas generating fuel for inflating the airbag/

So for example inflators are known, the combustion and filtering chamber of which is arranged ring-like around an initiator unit. In the centre of such a ring-shape inflator a cylinder-shaped initiating chamber is provided. There an initiator is mounted, which is activated by an electric impulse from the outside and thus causes the initiation. The initiating chamber is connected to the toroid-shaped combustion chamber by wall openings, in which combustion chamber the burnable gas generating solid fuel is provided. Here the real gas is generated. The gas reaches the filtering chamber by connecting channels, which filtering chamber encloses the toroidal combustion chamber. The gas is cooled and cleaned from contaminants in the filtering chamber. The gas escapes from the inflator by outlet-openings in the outer wall and is lead to the consumer.

Further inflators are known having a cylindrical design in which a long extending cylinder represents the combustion chamber and a cylinder encircling this combustion chamber has the outlet openings. The cylinder shaped initiating chamber is provided in the interior of such a tube-like inflator.

There an initiator is mounted, which is activated by an electric impulse from the outside and thus causes the initiation. The initiating chamber is connected to the tube-like combustion chamber by wall openings, in which combustion chamber the burnable, gas generating solid fuel is provided. Her the real gas is generated. The gas reaches by connecting channels a filtering chamber which tube-like encloses the combustion chamber. The gas is cooled and decontaminated in the filtering chamber. The gas leaves the inflator by the outlet-openings in the outer wall and is lead to the consumer.

Also from EP 0 382 552 A2 a tube-like inflator is known which includes two combustion chambers, each with one initiating unit. The cylinder-shaped outer wall in which the outlet openings are provided has in its interior a circle-like portion wall, which separates the outside cylinder in its interior into two chambers. In each of these chambers a cylindrical filtering unit is provided in which the cylinder-shaped combustion chamber with the fuel is provided. The cylinder shaped initiating chamber with the initiating compound is arranged in the interior of the combustion chamber. The two open ends of the cylinder-shaped, uniform outer wall having two chambers are closed by covers at each side. One initiator is arranged at each cover such that it protrudes into the initiating chamber.

Of disadvantage with this arrangement is, that it is not possible to influence the amount, the pressure and the speed and to adjust the to the relevant requirements when inflating the airbag, if only one fuel unit and one initiator is provided. Of disadvantage of the solution from EP 0 382 552 A2 is that the manufacture of the cylinder-shaped , two-chamber uniform outer wall is cost intensive and can only be realised for tube-like inflators. Also with the procedure maximal two combustion chambers can be formed, the size of which cannot be altered with increased production efforts.

It is therefore the object of the invention to provide an arrangement for an inflator of the above mentioned kind, which allows to control the generation of gas and therefore the inflating parameters flexibly, cost effective and with lowest possible production efforts according to the needs.

This object is according to the invention met by the characterising features of claims 1, 6 or 7. According to these at least two independent fuel units, each one having its own initiating unit, each in a closed, insertable casing or in each individual combustion chamber part or in each one of independent combustion chambers of which each one has a separate outer wall having the outlet opening are provided in a pyrotechnical inflator.

Advantageous improvements of the invention can be taken from the dependent claims. In connection with this the casings are opened from the interior when initiating the gas generating reaction. Also these casings may have a sector pattern cross-section. When inserting all cake-like casings into the combustion chamber they completely fill this circle-like combustion chamber. Further the initiating units and therefore the respective fuel may be initiated individually as well as simultaneously or time-wise delayed.

The advantages received by the invention especially reside therein that by the defined positioning of the fuel and by the variably timely delayed initiation wide spread of possibilities for generating gas can be realised. Thus the amount of gas, the inflating speed and the pressure in the airbag as well as in the inflator can be controlled. Now these parameters can be adjusted to the respective requirements. Further it is possible to re-use a fuel-/initiating unit, forming an encapsulated module in an independent, insertable casing having been initiated, without efforts. Also by a plurality of gas generating reactions being independent from each other, the safety can be improved at a mal-function, for example at a missing initiation, as another gas generating reaction may be activated. The arrangement according to the invention is of low cost, flexible as concerns the plurality of levels and is concerning manufacture to be easily realised.

The embodiments of the invention and advantageous improvements of these will following be described with reference to several drawings.

Figure 1: A pyrotechnical round-shaped inflator with insertable casings according to the invention;

Figure 2: A section of the combustion chamber of a pyrotechnical round-shaped inflator with cake-shaped insertable casings;

Figure 3: A pyrotechnical round-shaped inflator with a plurality of combustion chamber portions;

Figure 4: A section of the combustion chamber which forms a plurality of combustion chamber portions by radial partition walls;

Figure 5: A pyrotechnical tube-like inflator with a plurality of combustion chambers, in which per each combustion chamber an own independent wall having outlet openings is provided.

Figure 1 shows a pyrotechnical round-shaped inflator according to the invention with insertable casings. In this figure one of several initiating/fuel units 8 is shown, which is arranged in the uniform combustion chamber 25. The combustion chamber 25 is at its sides limited by the combustion chamber wall 14. The initiating/fuel unit 8 comprises an initiating unit, consisting of an initiator 16 and an initiating compound 18 and the real gas generating fuel 1. This initiating/fuel unit 8 is enclosed by a casing 8, the material and the thickness of the wall thereof is selected, that on the one hand the wall is destroyed by an explosion in the interior of the casing 19 but on the other hand withstands an explosion in a neighbouring fuel/initiating unit. This means that an opening of the casing 19 only takes place if a gas generating reaction of the fuel 1 is initiated by an electric impulse caused by the initiating unit 3. The casing has a sector pattern cross-section (see figure 2) and is inserted into the combustion chamber during assembly and then fixed when required. The casing with its initiating/fuel unit is independent from neighbouring casings. This means that its content can be separately initiated, without influencing the neighbouring casings. The gas escapes via the pre-filtering means 13, which as well is contained in the combustion chamber 25, but not in the casing, after opening the casing 19 by the combustion chamber openings 7 in the combustion chamber wall 14 into the filtering chamber. In the whole of the filtering chamber the hot and contaminated gas is cleaned and cooled, initially by a coarse filter 10 and then by a fine filter 11.

Then it escapes from the inflator by outlet openings 12, which are provided in the filtering chamber wall 15.

Figure 2 shows a section of the combustion chamber of a pyrotechnical round-shaped inflator having cake-like insertable casings. By this section a view into the whole of the combustion chamber 25 is given. Here there are two initiating/fuel units, a smaller one 8 and a bigger one 9.

The combustion chamber 25 is laterally limited by the combustion chamber wall 14. Each one of the initiating/fuel units 8 and 9 has an own initiation unit 3 and 4, which can be initiated independently from each other. In the application shown the casings 19 and 20 are different in size. The fuel amounts 1 respectively are different. Each one of the initiating/fuel units is contained in a casing 19 and 20, respectively. These casings have sector-pattern section and add to a circle like pieces of a cake. Therefore it is possible as well to have a decisive number of casings in the combustion chamber, as far as these form together a circular section. If one of the casings is opened by initiation in its interior, the gas will, as long as no gas directing plates direct the gas stream into the pre-filter 13 and all combustion chamber openings along the combustion chamber wall 14 can be utilised, as well as the totality of the filtering chamber.

If the initiating/fuel units of the casing can be initiated independently from each other, this leads to the effect that according to the requirements the airbag may be inflated only slightly, i.e. only by the gas from the small initiating/fuel unit 8, intermediary, i.e. only by the gas from the big initiating/fuel unit 9 or fully, i.e. with the gas from both initiating/fuel units 8 and 9 simultaneously. By this arrangement it would be possible to lay out the pressure in the airbag according to the requirements. In the application shown the inflator would work at three levels (with three steps). If one would fill the combustion chamber with even more from each other independent initiating/fuel units, the inflator could be operated with any number of steps. Further the inflating duration of the airbag could be accelerated or decelerated by a time-wise delay of the initiation of the two initiating/fuel units.

Figure 3 shows a pyrotechnical round-shaped inflator with a plurality of combustion chamber portions. In this figure a portion of the uniform combustion chamber is shown, which is divided into a plurality of combustion chamber portions. The division into a plurality of combustion chamber portions is described in connection with fig. 4. One combustion chamber portion 5 includes one initiation unit 3, consisting of one initiator 16 and one initiating compound 18 and the gas generating fuel 1. The pre-filter 13 is provided here as well.

The combustion chamber part is enclosed by the joint circular-shaped combustion chamber wall 14 and radial partition walls 21 (shown in fig. 4). The material and the thickness of the wall is set such, that this is not destroyed by an explosion in the combustion chamber area and such, that that the combustion chamber openings will be opened. Contrary the combustion chamber openings remain closed in case of an explosion in one of the neighbouring combustion chamber areas (see fig. 4). This means that the gas generating fuel 1 in the combustion chamber area is only then initiated, if the according initiating unit 3 initiates a gas generating reaction by an electric impulse. Then the combustion chamber openings 7 of the combustion chamber area open and the gas escapes via the pre-filter 13, which as well is situated in the combustion chamber area, into the filtering chamber.

In the filtering chamber the hot and contaminated gas is cleaned and cooled first by a coarse filter 10 and then by a fine filter 11. Then it leaves the inflator by the outlet openings 12, which are arranged in the filtering chamber wall 15.

Figure 4 shows a section of the combustion chamber, which forms several independent combustion chamber areas by radial partition walls.

In this section view into the whole of the combustion chamber 25 is granted. Here are two separated combustion chamber areas, a smaller one 5 and a bigger one 6. The total combustion chamber is limited by the combustion chamber wall 14 towards the filtering chamber. The combustion chamber areas differing is size are separated by radial wall 21. These partition walls 21 may be either individually, inserted into a groove, in the centre and in the combustion chamber wall or these may be arranged already v- or ster-like and are inserted into holding means in the combustion chamber. The partition walls 21 are designed such, that in case of a gas generating reaction in one combustion chamber, the fuel in a neighbouring combustion chamber area is not initiated. The combustion chamber areas 5 and 6 are independent from each other.

The gas leaves the combustion chamber area 5 via the combustion chamber openings 7 in the combustion chamber wall 14 and is decontaminated and cooled in the whole filtering chamber 24, as far as no deflecting plates are arranged. In the shown application example the combustion chamber areas are different in size. The fuel

amounts 1 and 2, respectively, are different. This causes, that the airbag according to the requirement is inflated only slightly, i.e. only by gas from the small combustion chamber area, medium, i.e. only by gas from the big combustion chamber area, or heavily (fully), i.e. by gas from both combustion chamber areas simultaneously. With this arrangement it would be possible to lay out the pressure in the airbag according to the requirements. In the shown example of application the inflator would work at three levels (steps). If one divides the combustion chamber by even more radial partition walls 21, the inflator could work with any number of levels (steps). As well by timely delayed initiation of the two initiating/fuel units the inflating duration of the airbag can be accelerated or decelerated.

Figure 5 shows a pyrotechnical tube-like inflator with a plurality of combustion chambers according to the invention, which has for each combustion chamber an own, independent wall with outlet openings.

This tube-like inflator forms two combustion chambers 22 and 23, independent from each other. In both combustion chambers 22 and 23 there are different amounts of gas generating fuel 1 and 2. Further an initiating unit 3 and 4 protrudes into each combustion chamber, the initiators of which may be initiated independent from each other. There is furthermore a pre-filter 3 in the combustion chamber. Each combustion chamber has an own combustion chamber wall with combustion chamber openings 7. Each one of the cylinder-shaped combustion chambers is surrounded by its own filtering chamber 24, in which the filters are arranged. Each filtering chamber is enclosed by its own outer wall, i.e. the filter wall with escape openings (outlet openings) 12. With such an arrangement there are in principle two independent tube-like inflators, which will be connected to each other 26. Furthermore the combustion chambers 22 and 23 are formed such, that by the freed (nascent) energy when initiating of the one, the fuel of the other combustion chamber will not be initiated. An initiation of the fuel will be activated only by the initiator in the individual combustion chamber.

After initiation of gas generating fuel 1 and/or 2 the gas escapes via the pre-filter 13 through the combustion chamber openings 7 into the filtering chambers, in which it

will be decontaminated and cooled. Thereafter it escapes from the inflator by the outlet openings 12 and reaches the consumer, i.e. the airbag.

Also this example of application (embodiment) concerns a three level (step) inflator. In case of initiation of the fuel 1 in the small combustion chamber 22, the airbag will be inflated only slightly. In case of initiation of the fuel 2 in the big combustion chamber 23 an airbag will be inflated to a medium stage. On initiation of the complete fuel 1 and 2 in the small and the big combustion chamber 22 and 23 the airbag will be inflated strongly.

With this arrangement there is the possibility to integrate even more combustion chambers having a initiating unit and a fuel unit in the inflator.

In addition by a timely delayed initiation of the two initiating/fuel units the inflating duration of the airbag can be accelerated or decelerated.

Patent claims

1. Arrangement for initiating a pyrotechnical inflator having a combustion chamber in several steps, especially for passive restraint systems in motor vehicles, in which the inflator includes at least two initiating units (3, 4) being controllable independent from each other and at least two gas generating fuel units (1,2) independent from each other,
characterised in that
one initiating (3, 4) and one fuel unit (1, 2) respectively are provided in a closed casing (19, 20) insertable in the combustion chamber.

2. Arrangement of claim 1,
characterised in that
the closed casing (19 or 20) is case of initiating a gas generating reaction in its interior is opened.

3. Arrangement of claim 1 or 2,
characterised in that
the closed casing (19 or 20) has a sector-pattern cross-section.

4. Arrangement of claim 1, 2 or 3,
characterised in that
at least two casings (19, 20) are provided in the combustion chamber.

5. Arrangement of claim 3 or 4,
characterised in that
all closed casings of a sector-pattern cross-section arranged in a combustion chamber (25) form a closed circle.

6. Arrangement for initiating a pyrotechnical inflator having a combustion chamber in several steps, especially for passive restraint systems in motor vehicles, in which the inflator includes at least two initiating units (3, 4) being controllable independent from each other and at least two gas generating fuel units (1, 2) independent from each other,

characterised in that

the combustion chamber is divided by partition walls (21) in at least two closed combustion chamber portions independent from each other, which each include an initiating unit (3, 4) and a fuel unit (1, 2).

7. Arrangement for initiating a pyrotechnical inflator having a combustion chamber in several steps, especially for passive restraint systems in motor vehicles, in which the inflator includes at least two initiating units (3, 4) being controllable independent from each other and at least two gas generating fuel units (1, 2) independent from each other,

characterised in that

in the inflator at least two independent combustion chambers (22, 23) are provided each including an initiating unit (3, 4) and a fuel unit (1, 2) and which are enclosed by at least two independent walls (15) having the outlet opening (12).

8. Arrangement of one of the preceding claims,

characterised in that

only one of the fuel units on its own or at least two fuel units (1, 2) are initiated simultaneously or timely offset by the equivalent initiating unit (3, 4).